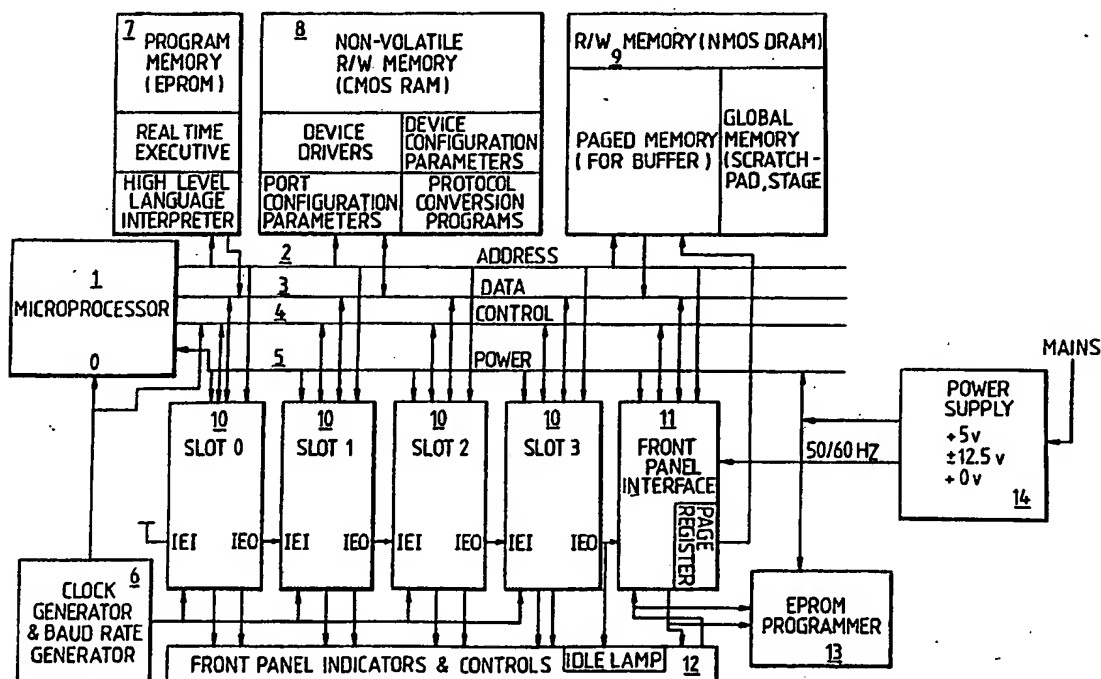




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(54) Title: DATA BUFFER/SWITCH



## (57) Abstract

A data buffer/switch box comprising a plurality of input/output interface cards (10) removably connected to a motherboard, the data buffer/switch box including circuitry for a plurality of different interface cards provided on the motherboard, and memory means (18) on the motherboard for storing device driver software for each type of interface card (10) connected to the motherboard.

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- 1 -

DATA BUFFER/SWITCH

5           The present invention relates to a data buffer/switch device for enabling a number of computers or computer terminals to share one or more devices such as computer peripherals or computer ports.

10           With the increasing use of computers in offices and, more particularly, the increasing use of personal computers, there exists a need to avoid expensive duplication of printers and other equipment such as modems etc. by enabling plural computers to  
15           share the same resource. This problem is partly addressed in the case of printers and modems by the provision of data buffer/switch boxes which enable a number of computers having the same type of output port to feed data to one or more printers or modems,  
20           switching between the computers being controlled automatically by the buffer/switch box so as to allow immediate use of a printer or a modem by any computer when it is free, but otherwise queuing the printing requests in order.

25           There are many different interface protocols by means of which computers communicate with, for example, printers, each of which requires a different type of interface and very different signal conditioning. Common interface standards are  
30           RS-232C, Parallel Centronics, IEEE-488, IBM 3270, and RS-449. There are other interface standards which are also used, but which are less common. Different computers use different ones of these interface standards for communications with attached devices  
35           and therefore, where there are computers of different types wishing to share the same device, some means is required to enable the buffer/switch

- 2 -

box to be able to communicate with the different interfaces of the different computers.

In the past this requirement has been met by a buffer/switch box having a predetermined number of dedicated input/output ports, the interface standards of the individual input/output ports being fixed. Such a device can avoid duplication of circuitry which is common to two or more ports, but suffers from a lack of flexibility in use as it cannot be re-configured to allow for changes in the equipment being used to access the printer. In order to provide a measure of flexibility the number of input/output ports needs to be much greater than is actually required for most applications in order simply to provide sufficient numbers of ports with the different interface standards that may be expected.

A second approach to the problem, favoured usually for more expensive/elaborate systems, is a modular approach in which the buffer/switch box includes a main printed circuit board, known as a motherboard, and a plurality of interface printed circuit boards or cards which connect with the motherboard. Each of the interface cards may provide circuitry for a different interface standard and the motherboard is provided only with the circuitry which is necessary to provide signal conditioning common to all of the interface cards. In practice, the motherboard contains little circuitry as there are few functions common to the widely different interface standards and therefore a particular configuration which is populated with several identical cards will duplicate circuitry on the cards needlessly. Typical duplication will include unusual power supply requirements, a clock generator and device driver program storage.

According to a first aspect of the present

invention a data buffer/switch box comprising a plurality of input/output interface cards removably connected to a motherboard, includes circuitry for a plurality of different interface cards provided on the motherboard, and memory means on the motherboard for storing device driver software for each type of interface card connected to the motherboard.

Thus, not only does the motherboard contain circuitry which is common to all the interfaces, but also circuitry which is common to groups of interfaces, thus reducing duplication whilst at the same time allowing the use of varying numbers of interfaces of different types, thus maintaining the benefits of a modular approach.

The data buffer/switch box may be utilized as a printer sharing device, enabling plural computers to use on or more printers, but may be used in a wide range of other applications, for example enabling computer port sharing by plural terminals and any other circumstance in which a data switch would be useful, including modem sharing, LAN node sharing, etc, etc. In particular, there are considerable advantages to be obtained by using the same box simultaneously as a VDU multiplexer and a printer switch.

In particular, it is envisaged that at least the Centronics Parallel and RS-232C Serial interface requirements will be provided on the motherboard as these are the most common interfaces used, but the requirements of other interfaces will also be provided as required.

Conventionally, data buffer/switches of the modular type with plural interface cards or computers with multiple interface cards incorporate the device driver software on the interface cards themselves as the software is specific to each type of interface card. However, this means that with several

- 4 -

identical cards there are several identical copies of the driver software. Furthermore, a substantial part of the usual address bus is needed on each interface card to permit the memory to be addressed, and more  
5 memory address space is used up than is necessary as each interface has to be assigned sufficient space for the largest anticipated driver device. Alternatively, a complex memory paging scheme must be used. A further problem is that integrated circuit  
10 components having memories of the required small size, typically 256 to 1024 bytes are no longer being made.

The present invention proposes further that only one copy of each device driver program that is  
15 required is provided on an EPROM. This is then loaded into non-volatile RAM on the motherboard when the respective interface card requiring this driver software is added or incorporated into the buffer/switch box and the EPROM is then removed.  
20 Thus, one non-volatile RAM chip can hold all the device drivers, in addition to various configuration parameters etc that may be required. Each device driver program then uses up only as much memory and memory address space as it really needs.

25 Data buffer/switch boxes enable a computer to send data to be transferred to the buffer/switch box which then stores or "buffers" the data and sends it to the device as required, the storing of the data in the buffer/switch box releasing the computer from the  
30 transfer operation and thus enabling a further task to be carried out on the computer. In those cases where the interface is truly bi-directional buffering occurs in both directions. Conventionally, buffer/switch boxes assign a predetermined amount of  
35 buffer memory to each input port. This is disadvantageous as, at any one time, only a small proportion of the total buffer memory may be used if

- 5 -

only a small number of computers are sending data to the buffer. Recently, systems have appeared which offer dynamic, that is to say variable, allocation of buffer memory, achieving this by assigning pages of memory, each of typically 256 bytes, to each input port, the number of 256 byte pages being able to be increased as buffer memory is added to the buffer/switch box.

According to a second aspect of the present invention, buffer memory is divided into a fixed number of pages, regardless of the amount of memory in the buffer, the size of each page being arranged to be increased as the buffer memory size is increased. This is achieved by suitable software control and has several advantages in terms of the speed at which the software can execute.

In order to provide for use of RS-232C Serial interfaces the motherboard needs to incorporate a clock generator whereby the baud rate for any particular interface card may be chosen from one of a number of standard frequencies. Each interface may require one or (less commonly) two of these frequencies. Conventionally, a baud-rate clock generator has been provided for each input/output channel, but this is expensive and inevitably causes duplication of circuitry. A second approach to the problem is to supply all the possible required frequencies to each interface card from the motherboard and to provide for selection of the particular required frequency on each interface card. Whichever of these methods is chosen selection is by means of switches which themselves add significantly to the cost.

According to a third aspect of the present invention, the motherboard incorporates a baud rate clock generator that outputs all the commonly required frequencies and provides these on a row of

pins; each RS232-C interface card having an at least four-way connector comprising two pairs of pins, a first pair for determining the baud rate of transmission from the interface card and a second pair for determining the rate of transmission to the interface card, a wire link being provided to connect pins of the first and second pairs together if the transmit and receive baud rates are to be the same; and a connecting lead connectable to the requisite pin on the clock generator and to one of the pins of the at least four-way connector.

By this means, if the relevant frequency desired for an interface is already in use from the clock generator (so that the pin is not available for attachment to the lead from the interface card, the lead may be attached to a spare pin on the interface card having the relevant frequency supplied to it. The arrangement provides that there will always be such a spare pin to which the lead from a second interface card may be connected and so on.

If different transmit and receive frequencies are required on an interface card then the wired jumper link may be removed and a second lead used in the same manner as the first. In this way a split baud rate may be offered to the interface card input/output port.

Preferably, each of the interface cards has a first and a second input/output port and the at least four-way connector is a six-way connector, the third pair of pins of which determine the transmit/receive rate of the second port, and wire jumpers being provided as required for connection to pins of the first and second pairs of the connector.

The advantage of this system is that a single baud rate generator with multiple outputs is much less expensive than multiple generators with single outputs, wire leads are simple, cheap and more



versatile than switches and a split baud rate can be provided to input/output ports very simply.

A further problem with the RS-232C interface standard is that although it is meant to be a standard, the way that the standard is interpreted varies considerably from one piece of equipment to another.

One example of a device constructed in accordance with the present invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a block diagram of the motherboard;

Figure 2 is a circuit diagram of the relevant part of an RS-232C interface card; and,

Figure 3A and 3B are circuit diagrams of a parallel Centronics interface card showing the input mode and output mode usage respectively.

With reference first to Figure 1, the motherboard has a microprocessor 1 with an address bus 2, a data bus 3 and a control bus 4, supplied with power via a power bus 5, and a master clock signal from a clock generator 6.

Attached to the buses are read-only program memory 7 (EPROM), some non-volatile (CMOS RAM) memory 8, some read/write memory 9 (NMOS DRAM), several slots 10 for interface cards adhering to various protocols, and a front-panel interface 11.

The read-only memory 7 consists of one or more EPROMs, containing a real-time executive and optionally a high-level language interpreter. The real-time executive provides standardised software interfaces to the device drivers required for each of the interface cards, and implements the logic associated with allocation and de-allocation of the paged buffer memory.

The non-volatile memory 8 is implemented in low-power CMOS RAM, and is provided with a battery

(not shown) to ensure that there is no data loss during power-down. It contains one device driver for each type of interface, port and device configuration parameters associated with each port and device, and  
5 optionally protocol conversion programs written in the high-level language for interpretation by the interpreter.

Inclusion of the device driver software in the non-volatile memory has the advantages already  
10 documented.

The read-write memory 9 is implemented in NMOS DRAM and is structured in the way described as the second aspect of the invention above.

In particular it should be noted that there are  
15 two conflicting requirements that arise when a microprocessor is required to address a greater amount of memory than is available in its normal address space. Thus, a paging system is necessary to access the bulk of the memory, whereby a page  
20 register is set to select some of the address lines, and the microprocessor address bus is used for the remainder.

However, this means that there is no memory that is always available, regardless of the contents  
25 of the page register. For microprocessors that have no internal read/write memory, this poses problems, as virtually all microprocessors require some scratchpad area, and a stack. The stack, in particular, must occupy a contiguous area of memory,  
30 and must be accessible without regard to the page register contents. In the device of this example an address scheme is implemented in which the 20 address lines from a 1 megabyte block of memory are mapped into two address spaces. The microprocessor sees two  
35 4096-byte blocks, at E000-EFFFh and F000-FFFFh. The latter is mapped so that it appears as a contiguous block of memory.

- 9 -

Thus, a portion of it is always available to the microprocessor for use as a scratchpad and stack, and a portion of it is selected by means of a page register, which is actually implemented as part of the front-panel circuitry.

The address line mapping of global memory at F000-FFFFh is:

	<u>Processor</u>	<u>Memory</u>
10	A0 .....	A0
	.....	
	A7 .....	A7
	A8 .....	A9
	.....	
15	A11 .....	A12
	A12 .....	=1
	.....	
	A15 .....	=1

Using this scheme, the contiguous address space is present at F000-FFFFh, regardless of whether the unit is populated with 64, 256, 512, 768 or 1024K bytes of memory (A8 is absent for 64K DRAMs).

Conversely, when the microprocessor refers to page E000-EFFFh, microprocessor address line A12 will be zero, and that selects the following mapping (where Rn is a bit from the page select register):

	<u>Processor</u>	<u>Memory</u>
30	A0 .....	A0
	.....	
	A7 .....	A7
	A8 .....	A8
35	A9 .....	A17
	A10 .....	A18
	A11 .....	A19
	R0 .....	A9

- 10 -

	.....	
	R7 .....	A16
	A12 .....	=0
	A13 .....	=1
5	A14 .....	=1
	A15 .....	=1

The result of this is that regardless of the amount of memory present, there will always be 256 pages selected by R0..R7. However, the size of these pages will be proportional to the amount of memory available, ie 256 bytes/page for 64K, 4096 bytes/page for 1Mb.

The memory locations used for the contiguous memory at F000-FFFFh will also appear in the paged memory, as the first 256 bytes of each of the first 16 pages.

The front panel interface 11 drives the front panel indicators, polls the front panel buttons 12, and generates a periodic interrupt once every mains cycle, to implement a realtime clock. As no front panel interface is required during EPROM programming 13 and reading, the front panel interface controls this function as well so that device driver software can be loaded from EPROM into non-volatile memory.

Two additional front panel indicators are driven directly by signals offered by each interface port (regardless of the type of the interface).

The interface slots 9 provide a standard hardware interface, to which cards may be attached to provide support for many possible communication protocols.

All necessary control signals from the microprocessor are provided on the slot connector, along with an interrupt chain implemented via IEI/IEO. Only a very small number of address lines needs to be provided, since no software needs to

- 11 -

reside on the interface card.

In order to minimise the cost of this flexibility, certain features that are the most likely to be required are implemented on the motherboard.

By providing a standardised hardware and software interface which is nevertheless sufficiently flexible to cope with any protocol that may be required, the optimum tradeoff is achieved between cost and flexibility.

In particular, the clock frequencies required for supporting RS-232C are provided for any interface that needs them, by the master clock generator 6. Additional power supplies are also made available by the power supply circuit 1. Additional functions which the power supply implements include a signal at mains frequency for implementation of the real-time clock, a power on reset signal and a lockout signal for the non-volatile memory (to prevent data corruption during power-up/down), and special voltage levels needed during EPROM programming.

Turning now to Figure 2, the interface card circuit illustrated provides an unusual solution to the problem of non-standard pinout of RS-232C.

The left-hand side of the diagram is quite conventional, and provides a means for a Dual Universal Asynchronous Receiver/Transmitter chip (UART), U3, to be supported by a microprocessor. The right-hand half of the circuit is duplicated for each channel. The functions of the two halves are identical, and only one will be described. The component designations on the diagram in brackets refer to the secondary channel. (Only the primary channel component designations will be used in this description).

A switch SW3 permits the user to choose a pin configuration which broadly complies with the

- 12 -

requirements for either DCE or DTE. This circuit has the unusual advantage that SW3 only requires four poles, despite controlling eight pins on the interface.

5       The top two poles of this switch simply effect the swapping over of the serial data pins, 2 and 3.

      In addition to the above-mentioned serial data pins, the interface must also support at least one flow control line in each direction. (This is used  
10   to indicate to the remote device one's readiness to accept data.) In this example, one line is provided in each direction, namely, the pin labelled DTR on U3 (to output this device's readiness to accept data) and the pin labelled CTS (to test the remote device  
15   for readiness for data).

      In this circuit, the flow-control output is only offered to one pin. In the DCE case, this is always pin 5. D4 and R19 provide isolation from pins 6 and 8.

20       In the DTE case, usage is divided roughly 3:2 in favour of pin 20 over pin 4. However, both must be offered, and a jumper J1 is provided to permit this selection. In this case, D3 and R17 perform the isolation function from pins 11,19.

25       The flow-control input is more difficult. There is very poor agreement about the pin to use in either the DCE or DTE case. However, one can be sure about the relevant voltage levels, namely, that a voltage more negative than -3v indicates  
30   Not-Ready-For-Data, whereas a voltage more positive than +3v indicates Ready-For-Data.

      The method adopted of connecting a resistor and diode in series with each pin which may be used in this way, means that the common point will be pulled  
35   to a negative voltage if any of the connected pins is at a negative voltage. Any pins at a positive voltage, and those that are not connected, do not

- 13 -

affect the result. Thus any of these pins will function for indicating readiness for data. The only compromise associated with this scheme is that a device that offers one of these pins permanently negative will be unable to receive data until that pin is disconnected.

It is a requirement of RS-232C/V.24 that inputs that are not connected should not have a voltage present on them. To this end, R15/16 are provided, to ensure that this is the case.

The DCE/DTE selection of flow-control input is effected by D1, D2 and SW3d. The relevant group of input pins is connected to the input U5 pin 4 by the diode. The inactive group is connected to +12v. This performs a dual function of ensuring that the other diode (D2/1) is turned off, so that those pins cannot participate in the flow control, and also puts a positive voltage on the various pins that might otherwise be assumed to be flow-control outputs; namely pins 11,19 for the DTE case, and pins 6,8 for the DCE case.

A six pin connector CN3 is provided to enable plural baud rate frequencies to be supplied from the baud rate generator 6 on the motherboard to the transmit line TA of the primary channel, the receive line RA of the primary channel and the transmit/receive line TRB of the secondary channel, by means of flying leads L1, L2. Jumpers J3 are also provided.

It will be appreciated that if TA,RA and TRB all require the same frequency than a single flying lead L1 from the appropriate pin of the baud rate generator 6 on the motherboard is all that is necessary, the jumpers J3 being connected to supply the same frequency to the TA and TRB lines. If a further interface card requires the same frequency then its flying lead can be connected to the spare

- 14 -

pin on this card, and so on.

If the TA, RA and TRB lines require different frequencies then plural flying leads can be connected back to the baud rate generator. Again the spare pin on each line will allow a further interface card to receive the same baud rate without requiring multiple pins on the baud rate generator.

Figures 3A and 3B illustrate the circuit of a bi-directional fully-buffered Centronics Interface card for attachment to the motherboard. This card is unusual, as it uses the same circuitry in different ways for input and output. The two figures illustrate the two modes of use, in each case all detail irrelevant to the operation in this mode has been omitted.

The pulse generator comprises U6b, U4a, U7d and C1, R4. Its mode of operation is to generate a negative-going pulse, of duration defined by R4, C1, whenever a positive edge occurs at the output of U6b.

During output, the pulse generator is used to generate the STRobe- pulse, indicating that the data is available on the data bus. R12 and C7 ensure that the data has time to become stable on the bus, before the STR- is sent.

On output, it is necessary to acknowledge receipt of the data from the PIO, and this is done via R6, C2 and U6a.

When functioning as an output, the BUSY line is simply monitored prior to sending data, via R7, C3, U6d, U4c.

When functioning as an input, the BUSY becomes an output line, indicating readiness to receive the next byte. In this mode, BUSY is asserted on the falling edge of the incoming STR-, via D1, C6, U7b, U5b, U8c. On the rising edge of STR-, the data is clocked into the PIO, and as a result, the PIO denies ARDY. This propagates after a short while



- 15 -

to BUSY via U6b. However, in the meantime, BUSY has been kept high due to the time constant of R3,C6. BUSY will then remain asserted until the microprocessor has time to read the data byte received.

On output, PRIME- functions directly as a control output, via U8a. (The connection via U5a, U7a, U6a is an unwanted side-effect, but which has no impact on operation.)

On input, it is necessary to register that PRIME- has gone low, even if it only occurred for a very short time. Therefore, a latch has been implemented. The operation of this is as follows:-

Initially, PRIME- is high, and as a consequence, U6c output is high, and PIO0 A3 input is low.

If PRIME- is pulled low by the remote equipment for at least timeconstant R8, C5, U6c output will go low, and as a result, U4b will permit PIO0 A3 to float high (pulled by R13). This causes open-collector gate U8a to turn on, pulling PRIME- permanently low (even after the initial stimulus has been removed).

As the falling edge of PRIME- is seen, U7a finds both inputs high for time R5C4, and generates a pulse rather like STR- pulse, and causing an interrupt to the processor, via PIO1, as for receipt of a normal character. This causes the processor to read the status, and establish that a PRIME- pulse has occurred.

The processor then attempts to reset the PRIME-capture latch as follows:

It re-defines PIO0 A3 as an output. It pulls it low, and then restores it to being an input. Assuming that the stimulus from the remote device has now gone (i.e. it is no longer pulling PRIME- low), this will have the effect of resetting the latch.

- 16 -

The processor again interrogates the status of A3, and if it finds that it is low, the reset has been successful. If it finds that it is still high, it assumes that the stimulus is still active, and  
5 sets a timeout, after which it comes back to try again.

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- 17 -

CLAIMS

1. A data buffer/switch box comprising a plurality of input/output interface cards (20) removably  
5 connected to a motherboard (30), the data buffer/switch box including circuitry for a plurality of different interface cards provided on the motherboard, and memory means (8) on the motherboard  
10 for storing device driver software for each type of interface card connected to the motherboard.

2. A data buffer/switch box according to claim 1, wherein the motherboard contains circuitry which is common to all the interface cards and also circuitry  
15 which is common to groups of interface cards, thus reducing duplication whilst at the same time allowing the use of varying numbers of interfaces of different types.

20 3. A data buffer/switch box according to claim 1 or claim 2, wherein device driver software for the Centronics Parallel and RS-232C Serial interface protocols is provided on the motherboard.

25 4. A data buffer/switch box according to any one of the preceding claims, wherein only one copy of each device driver software is provided on the motherboard.

30 5. A data buffer/switch box having a buffer memory (9) divided into a fixed number of pages, regardless of the amount of memory in the buffer, the size of each page being arranged to be increased as the buffer memory size is increased.

35 6. A data buffer/switch box according to claim 5, wherein the size of each page of buffer memory is controlled by resident software.

- 18 -

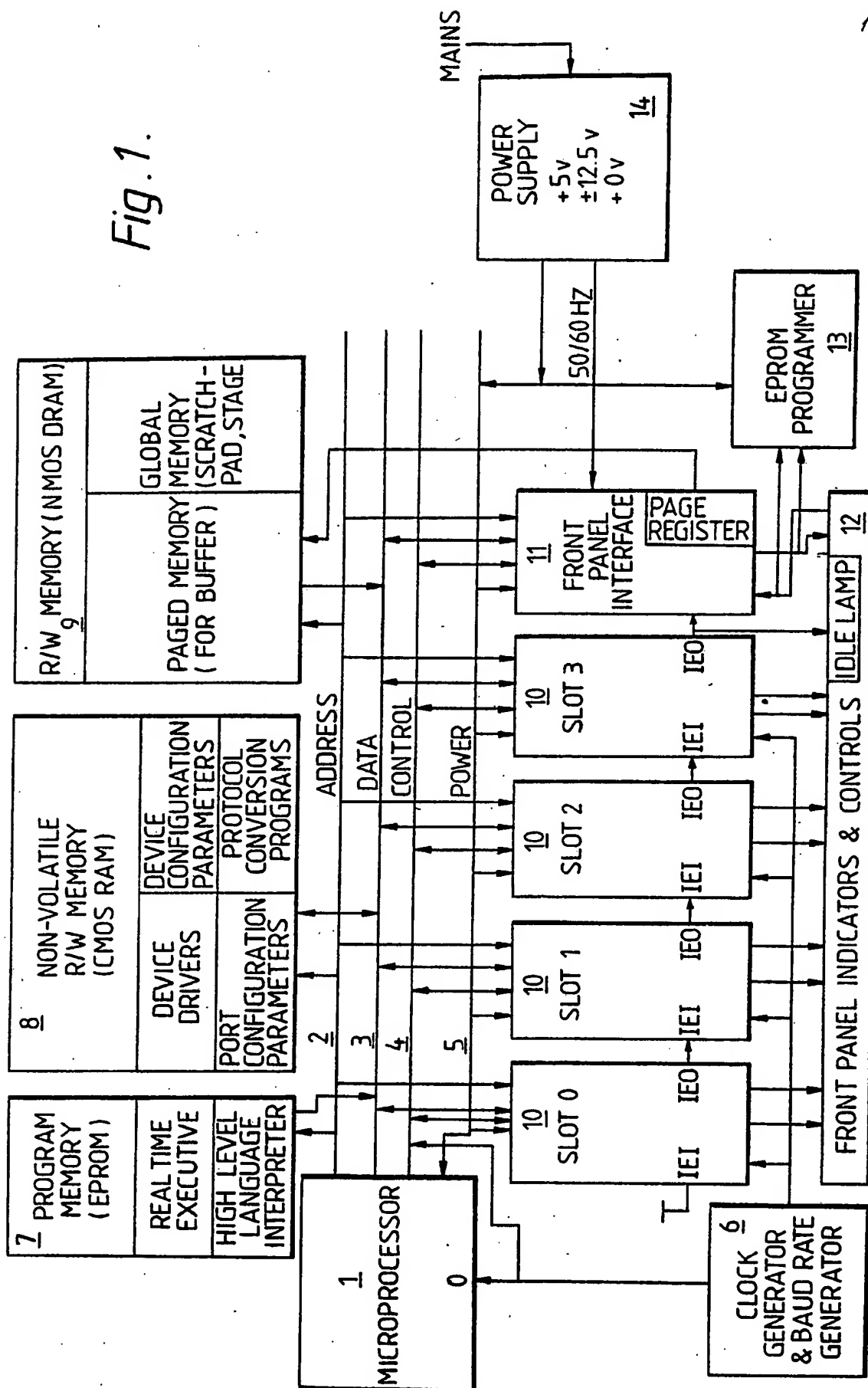
7. A data buffer/switch box comprising a plurality of RS-323C serial input/output interface cards removably connected to a motherboard, wherein the motherboard incorporates a baud rate clock generator that outputs all the commonly required frequencies and provides these on a row of pins; each RS232-C interface card having an at least four-way connector comprising two pairs of pins, a first pair for determining the baud rate of transmission from the interface card and a second pair for determining the rate of transmission to the interface card, a wire link being provided to connect pins of the first and second pairs together if the transmit and receive baud rates are to be the same; and a connecting lead connectable to the requisite pin on the clock generator and to one of the pins of the at least four-way connector.

8. A data buffer/switch box according to claim 7, wherein each of the interface cards has a first and a second input/output port and the at least four-way connector is a six-way connector, the third pair of pins of which determine the transmit/receive rate of the second port, and wire jumpers being provided for connection to pins of the first and second pairs of the connector.

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Fig. 1.



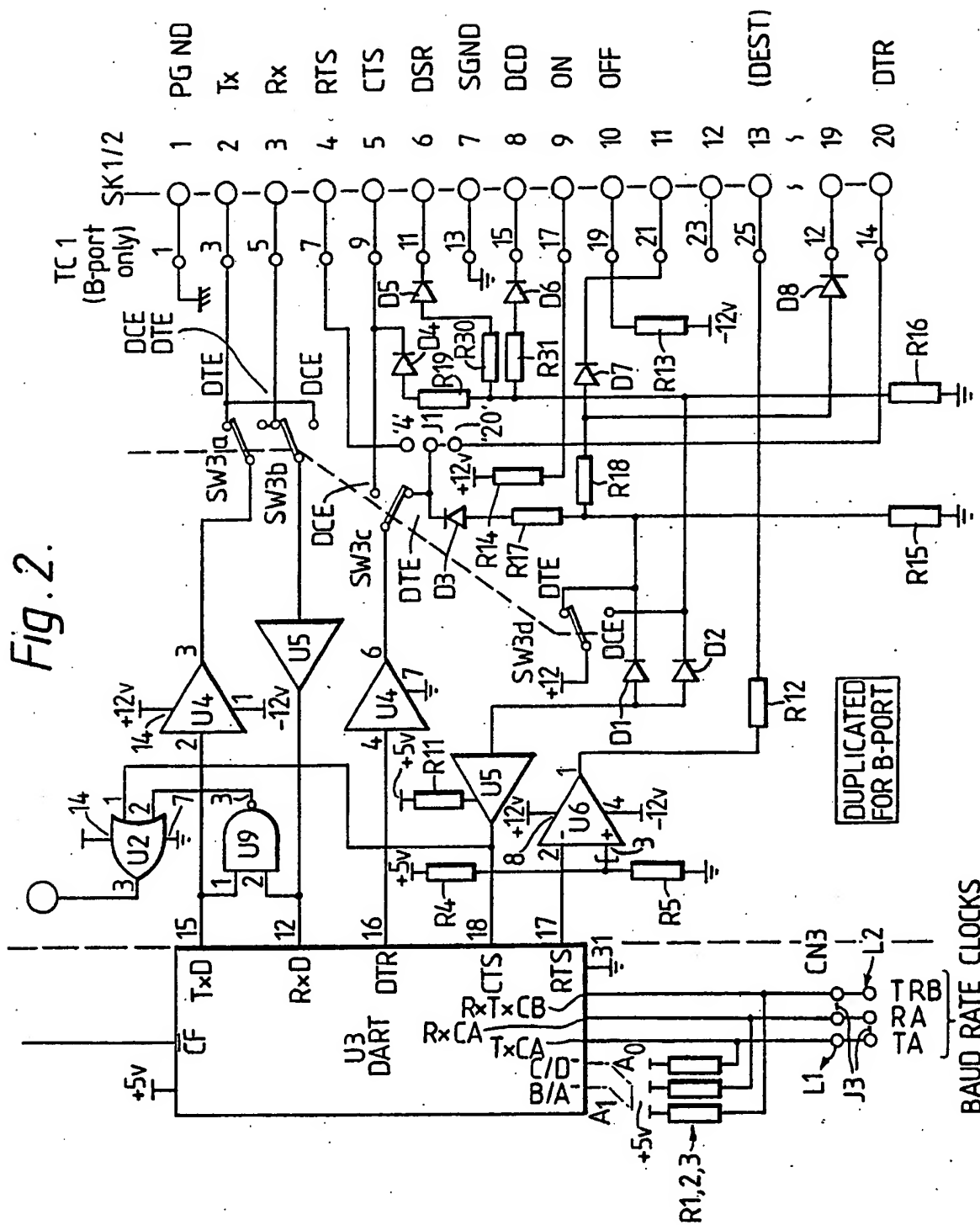


Fig. 3A.

INPUT MODE

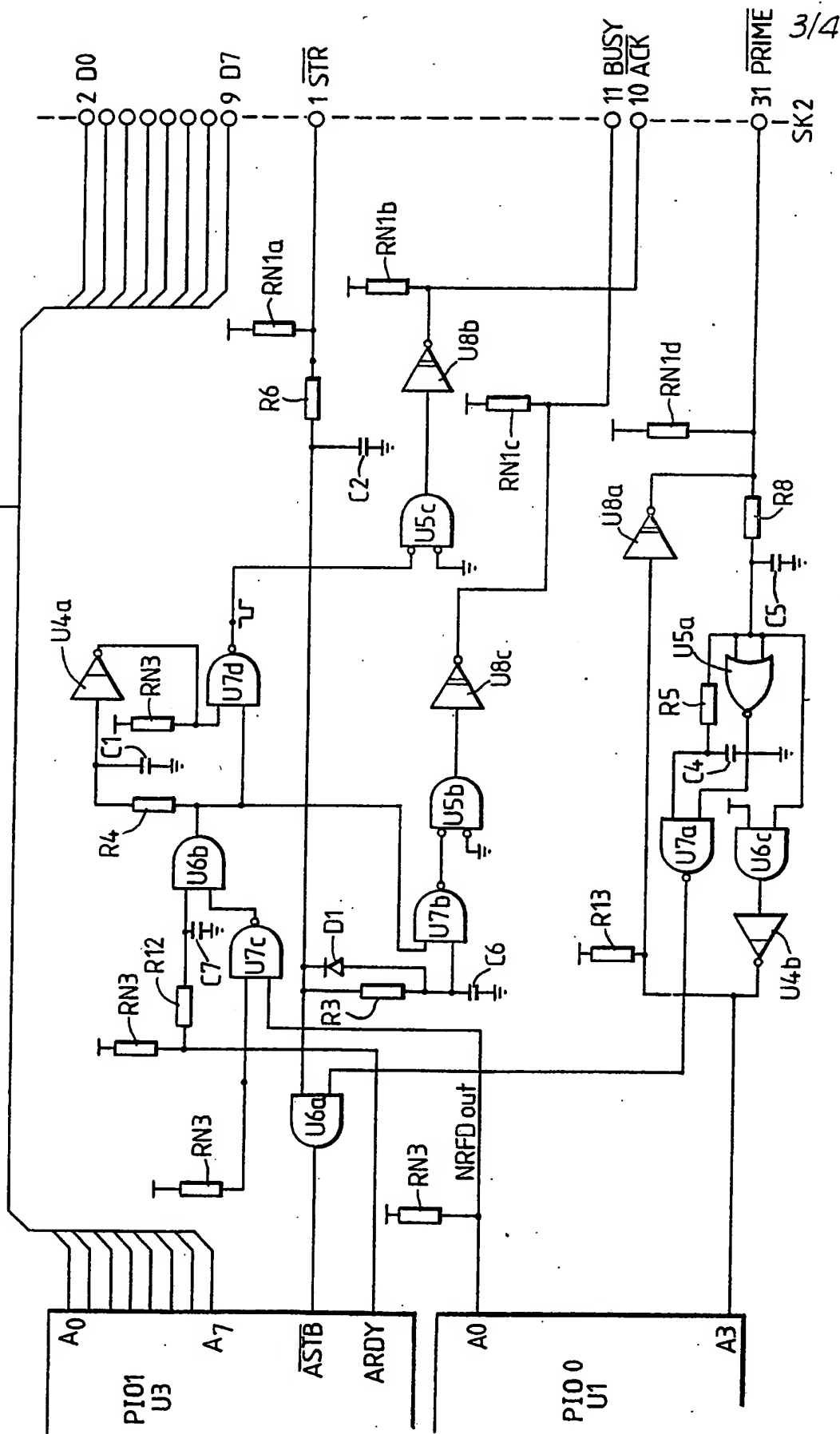


Fig. 3b.

